Photo: Mike Weimer, U.S. Fish & Wildlife Service

Executive Summary

Section 1

Section 1: Executive Summary

Photo: Michelle Fletcher

Working under the adaptive management concept, the Binational Executive Committee (BEC) recommended that a LaMP be produced for each lake by April 2000, with updates every two years thereafter. The LaMPs were to be based on the current body of knowledge and focus on implementation. Consistent with the BEC resolution, the Lake Erie LaMP 2000 was presented in a loose-leaf format with general tabbed sections that could be inserted into a three-ring binder. This format allowed the LaMP to be viewed as a working draft of the dynamic LaMP process, and adding new material and removing outdated information could easily update the document. However, in 2002, rather than updating the LaMP 2000 binder, a separate stand-alone progress report was produced.

For 2004, aspects of the LaMP 2000 and LaMP 2002 are combined to better reflect the BEC concept of one working draft. The document is slightly reformatted to better accommodate updates on LaMP progress as well as maintain documentation of the main history that formed the baseline and direction of the LaMP. It will truly become "The Lake Erie LaMP", an ever-changing accounting of the goals and progress of the Lake Erie LaMP process.

The environmental integrity of Lake Erie is dependent not only on various characteristics and stressors within the lake itself, but also on actions implemented throughout the Lake Erie watershed and beyond. Of all the Great Lakes, Lake Erie is exposed to the greatest stress from urbanization, industrialization and agriculture, reflecting the fact that the Lake Erie basin supports the largest population. Noting that most of the above conditions are related to land use practices, the LaMP has determined that changes in land use that represent a return towards more natural landforms or that mitigate the impacts of urban, industrial and agricultural land use, are the most significant actions that can be taken to restore the Lake Erie ecosystem. Also noting that addressing land use practices from a watershed perspective results in a more effective mechanism to achieve measurable results, the Lake Erie LaMP also endorses the use of watershed-based planning for all the tributaries around the lake. The watershed approach has been widely accepted as a necessary practice to achieve environmental restoration and protection.

Management Objectives

Earlier versions of the Lake Erie LaMP discussed the process for selecting a preferred future state of Lake Erie. Ecosystem Alternative 2 was chosen as the version that best highlights the importance and urgency of improving land use activities, continued diligence in nutrient management, and the vulnerability of fish and wildlife species to human activities. This alternative is also consistent with the themes of sustainability and of the multiple benefits to society of a healthy Lake Erie ecosystem. In 2004, the LaMP Management Committee adopted a vision statement consistent with Alternative 2.

In order to achieve this vision, ecosystem management objectives were developed for land use, nutrient management, natural resource use and disturbance, chemical and biological contaminants and non-native invasive species. Both strategic and tactical objectives are outlined. An Indicators Task Group was appointed by the Lake Erie Work Group and tasked with developing a proposed suite of indicators linked to the ecosystem management objectives, beneficial use impairments and habitat goals for the Lake Erie LaMP. The LaMP will also continue to work with SOLEC in the quest to develop the optimal indicators for lake progress.

The Lake Erie LaMP Vision Statement

A Lake Erie basin ecosystem...

Where all people, recognizing the fundamental links among the health of the ecosystem, their individual actions, and their economic and physical well-being, work to minimize the human impact in the Lake Erie basin and beyond;

Where natural resources are protected from known, preventable threats;

Where native biodiversity and the health and function of natural communities are protected and restored to the greatest extent that is feasible;

Where natural resources are managed to ensure that the integrity of existing communities is maintained or improved;

Where human-modified landscapes provide functions that approximate natural ecosystem processes;

Where land and water are managed such that water flow regimes and the associated amount of materials transported mimic natural cycles; and

Where environmental health continually improves due to virtual elimination of toxic contaminants and remedial actions at formerly degraded and/or contaminated sites.

Photo: U.S. EPA Great Lakes National Program Office

Beneficial Uses and Critical Pollutants

Experts in the respective disciplines completed beneficial use impairment assessments, the results of which were presented in the LaMP 2000 and 2002 reports. The research needs and data gaps presented in the 2000 report will be incorporated into a Lake Erie LaMP research and monitoring agenda that is being drafted as part of the 2004-2006 "Paths to Achievement" work plan. No changes in status from impaired or non-impaired are noted for any of the BUIs. There are however, a number of changes in the particular details of certain impairments. This is particularly true for the fish consumption advisories. The LaMP plans to have all beneficial use impairments re-assessed in depth by 2008.

Mercury and PCBs are designated as LaMP critical pollutants because they cause impairment across the basin, particularly in relation to fish and wildlife consumption advisories. An initial list of chemicals selected for intensive review was identified by the beneficial use impairment assessment reports. An additional list of pollutants of concern was also developed. As the Lake Erie LaMP progresses and specific problems and causes become better defined, additional chemicals from these lists may be designated as critical pollutants.

The Sources and Loads Subcommittee has integrated sediment quality data on a binational basis. Sediments are an appropriate medium for contaminant analysis, since many of the contaminants of concern preferentially adsorb to sediment. As primary depositional material, sediments not only implicate potential sources of contamination, but they also are the substrate by which food web uptake begins. In the near future, the LaMP Sources and Loads Subcommittee will perform comparisons between contaminants found in sediments and those found in fish tissue.

Sediment distribution maps of PCBs and mercury were originally presented in the 2002 LaMP report. These figures represent an evaluation of PCBs and mercury in bed-sediments as compared to predetermined aquatic biological effect levels called threshold effect levels (TEL) and probable effect levels (PEL). Dioxin concentrations collected by LaMP initiated projects were also presented.

For 2004, surficial sediment distribution maps are presented for chlordane, PAHs and lead, all chemicals that are associated with use impairments. Concentrations of these pollutants are presented as compared to biological threshold effect concentrations (TEC) and probable effect concentrations (PEC).

Chlordane is found above the PEC (17.6 µg/kg) in and downstream of all major urban areas in the drainage area. Exceedences of the TEC (3.24 µg/kg) are observed regularly in the western basin and south shore of Lake Erie. Less frequent are the occurrences of elevated chlordane above the PEC and TEC in bed-sediments along the north shore of Lake Erie.

Similar to chlordane, total PAHs (the sum of individual PAH compounds) are also found above the PEC (22,800 µg/kg) in and around all major urban centers within the drainage area. However, total PAHs are also found at concentrations exceeding the PEC in smaller urban areas, owing to the widespread abundance and persistence of PAH compounds in the environment. As expected, some of the highest concentrations (greater than 10 and 100 times the PEC) are found in heavily industrialized centers, but a few highly contaminated areas are isolated from major urban centers. These point-source signatures are manifest in the open lake environment, where concentrations exceeding the TEC (1,610 µg/kg) are found frequently in the western basin, the central basin and along the entire south shore. Fewer exceedences of the TEC are observed along the north shore of Lake Erie.

Similarly to chlordane and total PAHs, lead is found above the PEC (128 mg/kg) primarily in urban and industrial areas, and its distribution in the open lake basins is greater in the west compared to the east. Concentrations along both the south and north shores exceed the TEC (35.8 mg/kg), but exceedences are found more frequently along the south shore.

In an effort to organize the basin-wide assessment for the management and reduction of contaminated sediments, the Lake Erie LaMP Sources and Loads Subcommittee sponsored a workshop in the summer of 2002. Key points made during the workshop with regards to management of contaminated sediments were that:

- Certain agencies have the programs and funding to clean up contaminated sediments, but lack an approved location to dispose of the sediments.

- The contamination quality typically left behind after dredging projects may still represent some of the most contaminated sites remaining in the basin. Sediment remediation efforts typically focus on highly contaminated hot spots in well-defined zones, whereas sediment contamination in excess of biological sediment quality guidelines may be widespread. Moreover, criteria for sediment remediation (i.e., cleanup levels) are not as stringent as some sediment quality guidelines. To clean up to more stringent guidelines would be cost prohibitive, in many cases. However, the divergence between sediment cleanup guidelines and desired sediment quality must be addressed if we are to attain sediment quality that sets guidelines at contaminated sites in the Lake Erie basin.
- The apparent decreasing west to east gradient for many parameters in the open lake indicates that sources are primarily point sources into the system and not principally the result of atmospheric deposition.
- Controlling contaminant movement is not simple. Historically deposited contaminated sediments may be re-suspended and move downstream during storm events or may be disturbed by shipping activities.

In 2001, Environment Canada conducted a screening level survey of sediment quality in Ontario Great Lakes tributaries. Follow-up has already been initiated at the Lake Erie tributaries that had elevated levels of PCBs and/or mercury. Environment Canada and the Ontario Ministry of the Environment partnered to begin a program to track down possible active sources of PCBs.

The Great Lake Binational Toxics Strategy (GLBTS) is the principle mechanism used by the LaMP to address pollution prevention and reduction initiatives for PCBs and mercury. The status of a number of efforts to reduce mercury and PCB is tracked in the 2004 document.

The LaMP has recognized that emerging chemicals may impact on the LaMP's vision of a sustainable Lake Erie ecosystem and that a process is needed to evaluate the potential impacts, sources, and remediation options for emerging chemicals. The LaMP will be looking to the Great Lakes Binational Toxics Strategy, as the experts in persistent toxic substance reduction, to identify potential emerging chemicals of concern in the Great Lakes. The Great Lakes Binational Toxics Strategy has committed to developing an *Emerging Pollutants Evaluation Protocol* to evaluate the impacts of specific emerging pollutants in the Great Lakes.

Habitat

The Lake Erie LaMP has identified habitat loss and degradation as one of the top three stressors that must be addressed to restore Lake Erie. The alteration of natural lands through the loss of forests, wetlands, grasslands, and changing hydrology has had marked effects on biotic processes and fish and wildlife populations in the Lake Erie basin. In addition to loss of habitat, the beneficial use impairment assessments identified the loss of ecological function, or how efficiently the habitat supports the biological community that inhabits it.

The habitat strategy developed for the Lake Erie LaMP and presented in the 2004 LaMP provides a framework to guide and coordinate habitat protection and restoration efforts in the Lake Erie basin. The focus of the habitat strategy is on habitat preservation, restoration and improving the ecological function of habitats. It is also considers the preservation, restoration and enhancement of the ecological processes that create and maintain habitats. The LaMP recognizes that implementation of the habitat strategy will be done largely through linkages with already existing programs. It is most important to remember that this habitat strategy was developed so LaMP partner agencies can incorporate these ideas into their own agency programs to better direct/redirect their programs to influence habitat quality around the Lake Erie basin and to be more in line with the goals of the Lake Erie LaMP.

The Habitat Strategy defines habitat as "the dwelling place of an organism or community that provides the requisite conditions for its life processes." Guiding principles are offered to address scale, baseline condition, integrated management of land and water, protected areas, restoration goals and priorities, key threats to the aquatic system, and how to address key and emerging information needs. Four goals are outlined as follows: 1) Protect and maintain

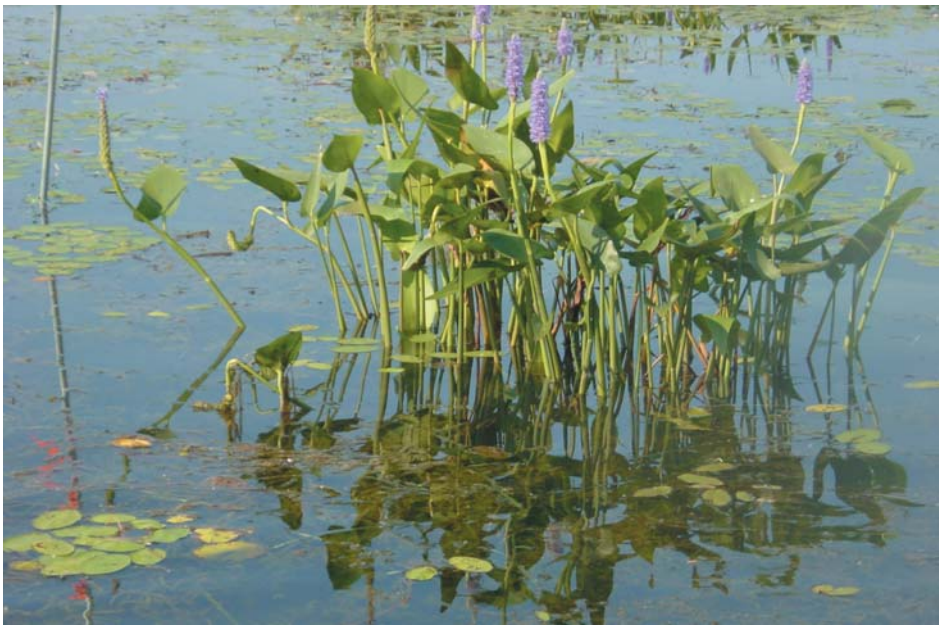

Photo: Mike Weimer, U.S. Fish & Wildlife Service

high-quality habitats and the ecosystem processes that sustain them in the Lake Erie basin; 2) Restore, rehabilitate, enhance and reclaim degraded habitats and impaired hydrological function in the Lake Erie basin; 3) Continue to promote the recognition that non-native invasive species have negative impacts on habitats in the Lake Erie ecosystem; and 4) Develop an integrated framework that will result in a consolidated vision of habitat for Lake Erie by adopting a common, basinwide standard for classifying, mapping, evaluating, tracking, and valuing habitats, their key attributes, and their regulating factors.

Human Health

Because the LaMP committees lacked expertise in human health issues beyond those associated with the surrogates of fish and wildlife consumption advisories, beach monitoring and drinking water standards, BEC established the Human Health Network. The Network serves as a forum to discuss human health issues, to relay information on new studies or emerging chemicals and their effects, and to identify any areas where additional research is needed.

Remedial Action Plans and Watershed Implementation

A new section in the 2004 LaMP allows for the presentation of the results of watershed-based implementation as well as the progress of Remedial Action Plans (RAPs). The importance of leaning on watershed management plans as the main mechanism for achieving LaMP goals was presented at the beginning of this summary. Future updates to the Lake Erie LaMP will allow progress in watersheds to be tracked in this section. For now, this section briefly describes the progress of four watershed efforts initiated recently, as well as the progress of the Lake St. Clair Management Plan. The many activities accomplished by the RAPs since 2002 are highlighted. Most significant is the re-designation of the Presque Isle Bay AOC to "in recovery" status. The Black River (OH) has also "upgraded" the fish tumor BUIA from impaired to "in recovery".

Significant Ongoing and Emerging Issues

At the request of BEC, an effort was initiated to better coordinate monitoring on the Great Lakes, to inventory existing monitoring programs and to provide easy access to existing monitoring data. The information will available through www.binational.net. A rotational schedule to focus monitoring events on each lake has been created. Lake Erie is targeted for 2004 and again in 2009.

The dynamic nature of Lake Erie means that things change, often unpredictably. The adaptive management approach of the LaMP process accepts the fact that change is inevitable.

The challenge to the LaMP is to keep abreast of lake conditions, identify and encourage research in areas needed to make the appropriate management decisions, and modify management goals and actions when needed.

Of the approximately 170 non-native invasive species (NIS) in the Laurentian Great Lakes drainage basin, about 132 NIS are found in the Lake Erie watershed including: algae (20 species), submerged plants (8 species), marsh plants (39 species), trees/shrubs (5 species), disease pathogens (3 species), molluscs (12 species), oligochaetes (9 species), crustaceans (9 species), other invertebrates (4 species), and fishes (23 species). The increase in NIS during the 20th century is attributed to the shift from solid to water ballast in cargo ships and to the opening of the St. Lawrence Seaway in 1959. The Lake Huron-Lake Erie corridor has been identified as one of the four invasion "hotspots". The hotspots represent less than 5.6% of the total Great Lakes water surface area, but account for more than half of the NIS documented since 1959.

There have been reports of new invaders in Lake Erie. Protozoans (Rhizopoda), *Psammonobiotus communis* (two sites east of Wheatley to Rondeau on the north shore of Lake Erie) and *P. dziwnowii* (eastern Lake Erie), were reported in a 2002 survey of Lake Erie. It is likely that these euryhaline species entered the Great Lakes through ballast water. *Psammonobiotus communis* is pandemic, whereas *P. dziwnowii* was found only on the Polish coast of the Baltic Sea before it was reported in Great Lakes waters. A new species, *Corythionella golemanskyi*, also has been described. These three species have been described from several Great Lake locations where they occur in beach sand. It is likely that these species became established long ago, but investigators simply had not looked for them.

In 2000, there were unusual sightings of the Chinese bighead carp, *Hypophthalmichthys nobilis*. On 16 October 2000, the third specimen ever of Chinese bighead carp was caught in a trap net on the west side of Point Pelee in the western basin of Lake Erie. The competition threat from this species exists for all fish because each fish species consumes plankton early in development. There is also anticipated competition between the Asian carp and adults of commercially important lake whitefish, *Coregonus clupeaformis,* and bloaters, *Coregonus hoyi*, that rely on plankton.

The invasive round goby fish has continued to expand its range in the Great Lakes basin. The fish entered western Lake Erie in 1993 and, since 1999, has occupied all three basins of the lake. There were an estimated 14.5 billion round gobies in western Lake Erie in 2001, but the numbers now are much less. Populations of dreissenid (zebra and quagga) mussels are steady or declining. The development of thick mats of algae along shorelines, especially in the eastern and central basins, reduces the living space available for dreissenid mussels. Zebra mussels have all but disappeared from eastern and central basins, being supplanted by quagga mussels. Overall mussel densities seem to be lower than in recent previous years, possibly because there are so many gobies now in the lake. Gobies will likely become an acceptable source of food for walleye and are now common in the diets of almost all of the Lake Erie sports fish.

Management options to control NIS become increasingly more limited once they colonize a waterbody, become established, disperse and ultimately affect either native species or habitat.

Photo: Upper Thames River Conservation Authority

Long-term records relating to Lake Erie's nutrient status suggest a process of reduced nutrient status. Concentrations of total phosphorus in the water, averaged over the whole year have been falling by about 0.2 mg/m^3/yr. However, the amounts of nutrients present in the water in early spring have continued to rise, extending a trend that was first seen in 1995 to eight years. Much of the among-year variation in the amount of phosphorus entering the lake over the last few years is due to the intensity and timing of storms, which cause flooding and erosion, rather than to municipal inputs. Data from the last several years indicate that more phosphorus is leaving Lake Erie in the waters of the Niagara River than is entering the lake from the major tributaries.

The diversity and abundance of invertebrate animals, especially mayflies and net-spinning caddisflies in the wave-washed zone of the shoreline, has dropped markedly since the last time they were surveyed in the 1970s.

Evidence seems to suggest that we are seeing new pathways of internal cycling of nutrients, likely caused by the activities of dreissenids. However, the consequences of physical (weather-related) influences cannot be ruled out as an accompanying explanation for the apparent increasing frequency and extent of central basin anoxia events. Persistent periods of spring turbidity may be due to the effects of heavy fall and winter storms, which contribute more sediment for a given amount of precipitation than summer storms. Also, cold water is more viscous than warm water, causing particles to settle more slowly. Spring water temperatures in 2002 and 2003 have been among the coldest on record, perhaps partly accounting for the greater concentrations of spring turbidity and possibly associated nutrients.

The average water temperature of Lake Erie has risen by 0.4 degrees C over the past 18 years. Between 2004 and 2090, our climate is expected to continue to become warmer. As lake levels decline and shoreline armoring uncovers, the potential for nearshore emergent and submergent vegetation to recolonize these areas is high. There is potential to restore nearshore habitats and processes and protect shorelines on a lake basin scale, if the newly exposed lands are managed appropriately.

Lake Erie's fisheries differ strongly from other Great Lakes, because they rely predominantly upon natural reproduction of native species within the lake and its tributaries. Rehabilitation of these environments is critical to restoration of biological integrity of the Lake Erie ecosystem. The Lake Erie Committee of the Great Lakes Fish Commission has established goals and objectives to define rehabilitation, and to recognize that the Lakewide Management Plan is vital to recovery of ecosystem integrity. A healthy fish community will be a measure of restoration of that integrity.

Blooms of blue-green algae (Cyanobacteria) are again becoming noticeable at certain places and times. Some species produce chemicals (microcystins) that are potent toxins to humans and wildlife. Samples collected in various open-water areas revealed a correlation between locations where blue-green algal pigments were most abundant and places where dreissenid mussels were abundant.

Since 1999 there have been annual large scale die-off events of fish, fish-eating birds and mudpuppies (a native aquatic amphibian) observed in Lakes Erie, Huron and, in 2003, Lake Ontario. These events have occurred annually in Lake Erie and it is here where the largest toll of fish and wildlife has occurred. The type E botulism bacterium is believed to be the cause of the die-off events. What has been rarely observed in the past is apparent botulism type E poisoning of hundreds, if not thousands of fish-eating birds as well as dead fish and mudpuppies washing ashore in unprecedented numbers during the late summer and early fall period. Fall and early winter events have been less of a perceived problem as the number of recreational users on the beaches at that time of year is much lower. The current thinking on what is causing these outbreaks is that ecological changes in the Great Lakes due to recent invasions of zebra and quagga mussels and round gobies have changed the way the food chain operates, with much more energy in the system staying on or near the bottom of the lake. Formerly, the fish community was much more balanced and it is thought that very rarely would the benthic community, where the botulism toxin is thought to be produced, be able to mobilize the toxin into the upper levels of the food web. Consequently, much of the current research effort is working to determine if this theory is indeed valid.

Paths to Achievement

By soliciting the involvement of jurisdictional agencies around the lake, researchers, the private sector and the public, it is the LaMP's intention that the most important Lake Erie management and research needs are identified and that the limited resources will be applied to these priorities. The LaMP is working in collaboration with the Lake Erie Millennium Network to identify the research and management needs of the lake and ways to fill these gaps. The LaMP has developed a work plan that includes short term and long-term actions. The work plan specifically focuses on the needs that the Lake Erie LaMP has identified and most actions listed are binational in nature. Each LaMP partner must review their own programs in relation to how they can complement the binational programs underway.

It is important for the LaMP to continue to report the good things going on in Lake Erie as well as identifying the areas where remediation and protection are needed.

Photo: Michelle Fletcher